broadband satellite backbone networks. Traditional local exchange and long-distance carriers have been merging at a rapid pace, in part to achieve the efficiencies necessary to deploy broadband facilities more expeditiously.[61]

Increases in computing power and bandwidth further impel demand for Internet and other information services. Internet Service Providers have emerged as an entirely new class of telecommunications carriers who are just beginning to generate tremendous revenues.[62] There are now over 4,300 Internet Service Providers (ISPs) in the United States, more than triple the number at the beginning of 1996.[63] One estimate places the size of the ISP market for access services at nearly $6.5 billion in 1997, up from just $880 million in 1995.[64] The market is expected to grow to $50 billion by 2000.[65] Online Service Providers (OSPs) like America Online, CompuServe, and the Microsoft Network have likewise seen their growth accelerate in the 1990s as consumer demand for online services skyrocketed. The revenues of the largest OSP, AOL, have increased from $38 million in 1993 to over $1.4 billion today.[66]

It is impossible to estimate with precision the demand curves for broadband services. Such estimates would require the availability of time-series or cross-sectional data which simply do not

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[61] In 1996, telecommunications mergers topped $100 billion in value; 1997 followed with more than $90 billion in deals. P. Truell, Buoyant Stock Market Keeps Mergers in Pipeline, N.Y. Times, Jan. 5, 1998, at D3.

[62] Comments of the United States Internet Providers Association, *Usage of the Public Switched Network by Information Service and Internet Access Providers*, CC Dkt. No. 96-263 (F.C.C. filed Mar. 24, 1997).

[63] J. Rickard, Boardwatch Directory of Internet Service Providers (Fall 1997), http://www.boardwatch.com/isp/fall97/intro1.html.

[64] P. Elstrom, New Boss, New Plan, *Business Week*, Feb. 2, 1998, at 122; Terrestrial Services Market Reaches $218.3 Billion, According to IDC, *PR Newswire*, Jan. 21, 1997.

[65] P. Vadlamudi, Amid the Churn and Change, ISP Market Keeps on Growing, *Investor's Business Daily*, Nov. 13, 1997, at A8 (citing Maloff Group estimates).

[66] 1996 and 1997 America Online Annual Reports.

exist. And, in any case, such estimates would rapidly be overcome by new technological developments, which fundamentally affect the nature of services available through the Internet and hence the underlying consumer demand curves.

However, it is quite clear that the demand for more capable and capacious data delivery services is growing rapidly. Consumers report their desire to purchase broadband services, and when offered the opportunity, they are increasingly doing so. Businesses increasingly depend on broadband services to offer an ever-widening array of on-line products, market other products, and exchange data needed for business-to-business electronic commerce.

IV. TECHNOLOGIES FOR PROVIDING ADVANCED TELECOMMUNICATIONS SERVICES

Broadband services to homes and business have heretofore been provided by two, telephone-based technologies; leased lines (e.g. T-1 and fractional T-1 lines) and Integrated Services Digital Network (ISDN) services. T-1 lines, typically used by businesses, universities and other large organizations, provide 1.544 Mb/s bi-directional connections, but at costs of up to $2,000 per month.

ISDN technology uses digital modems on both ends of an ordinary copper wire that utilize much more of copper's potential bandwidth and boost capacity by a factor of 4 – to a maximum of 128 kb/s.[67] ISDN is now available to 85 percent of residential access lines and 100 percent of business lines.[68] Although upgrading the network for ISDN is quite expensive,[69] most of the costs have already been borne.

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[67] ISDN supplies two 64 kb/s channels that can be used for either voice or data, together with one 16 kb/s network signaling channel.

[68] Robin Gareiss, Mapping a High-Speed Strategy, Data Communications, Apr. 1997, at 62. As of the end of 1995 (the most recent date for which accurate FCC data is available), ISDN was available on 62 percent of access lines (65

ISDN is, at best, only an interim solution to increasing bandwidth demand, for two reasons. First, ISDN does not offer enough bandwidth for certain applications, like delivering video.[70] Second, ISDN relies entirely on the circuit switches designed for voice traffic, and these switches will become increasingly congested with data traffic as a result of increased Internet usage.[71] Approximately one million subscribers, nearly 90 percent of which are businesses, are currently using ISDN.[72] The absence of standards, installation problems and high prices[73] have slowed deployment of ISDN and limited initial customer acceptance. By 1998, the initial customer set-up cost for ISDN had decreased considerably, and monthly rates for ISDN service were falling,[74] but these improvements appear to have come too late for a technology that is now seen as offering only a limited increase in functionality.

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percent of Bell Companies' lines) and 20 percent of all switches were ISDN capable (29 percent of Bell Companies' switches).

[69] Because ISDN "cannot be done on a per-user basis," it can cost upwards of $500,000 to upgrade a switch to offer ISDN. R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL (June 20, 1997). That is the cost of upgrading the software in the switch; some central offices with older switches need to replace the switch altogether to be able to offer ISDN. *See* J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global *19 (Mar. 13, 1997).

[70] *See* J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global Table 3 (Mar. 13, 1997) ("key hurdles" for ISDN include "inadequate for multimedia apps (videoconferencing)."); R. M. Maclellan, Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL *7 (June 20, 1997) (stating that "decent videoconferencing" requires "at least 128-384 kb/s"); *id.* ("Digital TV requires at least 1.5 Mb/s downstream (using MPEG compression) with HDTVs requiring will above that.").

[71] *See* R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL (June 20, 1997) ("[A]n ISDN connection is really no different than one for a basic POTS line or a modem-based data call. Each ISDN user chews up a dedicated line card when on line and utilizes bandwidth on the trunks leaving the CO switch.").

[72] It has been estimated that there are currently about 1.1 million ISDN lines in service. About 80,000 of these are PRI ISDN lines. Residential ISDN lines now comprise a very small portion of the total installed base, at about 12 percent. T. Rudisill, et al., Raymond James & Associates, Ind. Rpt. No. 1816648, Local Access Market (Nov. 21, 1996).

[73] Because the duration of an ISDN call is directly proportional to the strain it places on the voice network, ISDN pricing is usage-based, which is difficult for many residential users to accept. *See* J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global (Mar. 13, 1997) ("[T]he cost to heavy end users can reach or exceed $100 per month, not very economical, especially in the face of competition from cable operators which promise much greater bandwidth at a cheaper price.").

[74] *See* R. Kahan, ISDN: "Not Dead Yet", *Teleconnect*, Apr. 1997, at 115; Bell Atlantic Press Release, Bell Atlantic Cuts ISDN Prices Again, July 24, 1997.

Two new technologies are fundamentally changing the market for digital broadband services: Cable television based ("cable modem") technologies and telephone based xDSL technologies. Other technologies, including terrestrial and satellite wireless, and electric utility based services, have the potential to serve particular market segments and/or to compete eventually for the entire marketplace.

A. Cable television based ("cable modem") technologies

Virtually all U.S. households have access to cable television.[75] Most cable networks were built for at most 54 video channels on coaxial cables with 350 MHz of usable bandwidth.[76] Between 80 and 90 percent of all cable networks do not allocate any significant amounts of bandwidth to upstream data; the closest these networks generally come is a sliver of bandwidth for pay-per-view requests.[77]

During the past few years, cable operators have invested heavily to upgrade their networks to hybrid fiber-coax (HFC), which greatly expands bandwidth and provides the ability to activate a "return path" for two-way communications.[78] On HFC networks, signals are sent from the cable head-end via fiber-optic cable to neighborhood "drop sites" or "nodes" where it is shunted to coaxial cables and makes its way to subscribers' premises. According to industry analysts, between one-third and one-half of all cable systems have undergone or are now undergoing HFC upgrades;

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[75] Today cable networks passes about 95 percent of U.S. households, two thirds of which subscribe. National Cable Television Association, Cable Television Developments 1 (Fall 1997).

[76] Third Annual Report, Annual Assessment of the Status of Competition in the Market for the Delivery of Video Programming, CS Dkt. No. 96-133, paras. 16-17 (F.C.C.1997).

[77] T. Arnold and P. Hyzer, Building New On-Ramps for the Information Superhighway: A Look at New Cable Modem and ADSL Technologies, Dec. 13, 1996, http://www.seas.upenn.edu/~hyzer/tcom500/index.html.

[78] Cox Communications, for example, is investing nearly $4 billion to upgrade its networks. See Duesterberg and Pitsch, p. 25.

by the year 2000, several analysts predict that 60 percent of cable plant will be upgraded to HFC.[79] Relative to ADSL upgrades and deploying fiber to the curb, HFC is relatively cheap, although at high penetration rates the costs for a fully interactive HFC system can exceed those for a switched digital infrastructure.[80]

A HFC architecture is required to support the most promising access technology on cable networks, the cable modem.[81] Cable modems transmit data over cable networks at high speeds – up

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[79] Industry analysts report that HFC network architecture currently exists in approximately 35 percent of all cable systems, and that over one-third of all cable subscribers are served by systems employing HFC architecture. Third Annual Report, Annual Assessment of the Status of Competition in the Market for the Deliver of Video Programming, CS Dkt No. 96-133, para 172 (F.C.C. 1997). *See also* D. Shapiro, et al., Deutsche Morgan Grenfell Inc., Ind. Rpt. No. 1964154, Modems *3 (Aug. 27, 1997) ("Although it is expensive to complete the hybrid-fiber coax (HFC) rebuild or upgrade that is generally a precursor to deploying a two-way cable modem service, what is often overlooked is that several operators have been upgrading their networks diligently for the past three, four, and five years, and a great deal of this money has already been spent."). Allied Business Intelligence estimates that 69 percent of the cable industry's total plant mileage will be within HFC networks by 2000. Allied Business Intelligence Press Release, http://www.alliedworld.com/Site/News/PressReleases/CATV.pdf. Morgan Stanley, however, does not see this happening, even after 10 years. *See* Meeker, Morgan Stanley, Dean Witter, Co. Rpt. No. 2578415, @Home *4 (Aug. 20, 1997) ("Some individual MSOs will likely exceed the industry averages, but it is important to note that one-third of the US is served by smaller private cable companies that are for the most part capital-constrained. Thus, even after ten years, it is unlikely that more than 60% of the US will be served by 2-way HFC.").

[80] The cost of upgrading to HFC is approximately $200 per home passed, and only an additional $25 to add bi-directional capabilities. K. Maxwell, ADSL Forum, Cable Modems and ADSL, http://www.adsl.com/adsl_vs_cable.html. *See also* Shapiro, et al., Deutsche Morgan Grenfell Inc., Ind. Rpt. No. 1964154, Modems - Industry Report *8 (Aug. 27, 1997) ("After the upgrade is complete, operators must then place reverse modules in their amplifiers to activate the return path, but at an estimated $10-$15 per home passed, this process is relatively trivial compared to the time and expense (about $175-$225 per home passed) of the initial upgrade or rebuild."). There are however, difficulties with return path operation, and even in the absence of noise issues (return path noise funelling) the costs for an HFC architecture which provides guaranteed bandwidth to subscribers at a high penetration rate can be higher than for switched digital infrastructures including FTTC or VDSL. *See* C. Eldering, N. Himayat and F.M. Gardner, "CATV return path characterization for reliable communications," *IEEE Communications Magazine*, vol. 33, no. 8, pp. 62-69 (August 1995) and N. Omoigui, M. Sirbu, C. Eldering, and N. Himayat, "Comparing Integrated Broadband Architectures from an Economic and Public Policy Perspective," in *The Internet and Telecommunications Policy Research*, G.W. Brock and G.L. Rosston, eds. (Lawrence Erlbaum Associates, Mahwah, NJ, 1996).

[81] Unlike ADSL and ISDN, which offer broadband service using the existing infrastructure, cable modems require the upgrade of present uni-directional, coaxial cable-based networks to HFC. Cable modems run data from the user's coaxial cable into a standard port in the user's computer. One television channel (in the 50-750 MHz range) is allocated for downstream data, and another channel (in the heretofore unused 5-42 MHz band) is reserved for upstream data. The downstream channel offers speeds of up to 36 Mb/s. Upstream throughput is estimated at 500 kb/s to 10 Mb/s. It is estimated that individual users will experience access speeds of 500 kb/s to 1 Mb/s, but possibly more, depending on the transmission technology used. In addition to significantly higher throughput rates, cable modem subscribers benefit from almost zero latency: like a LAN, cable modem users are constantly connected to the network, so there are no dial-up procedures or busy signals.

to 30 Mb/s.[82] Cable modem technology avoids many of the problems associated with ADSL. Whereas ADSL is limited by distance and by the condition of the copper lines, virtually the entire cable infrastructure is capable of accommodating the bandwidth needed for cable modem services. On the other hand, some observers have expressed concerns about the scalability of cable-based technology. Even with HFC infrastructure in place, cable networks use a tree-and-branch architecture, with all users ultimately sharing a common transmission path.[83] As a result, each new user limits the bandwidth available for other users, possibly resulting in congestion problems. Many analysts, however, believe that scalability problems can be resolved.[84]

Cable modems have passed the trial stage and several companies have begun deploying data services through offerings such as @Home and Roadrunner.[85] Cable companies that are currently

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[82] Kim Maxwell, Cable Modems and ADSL, ADSL Forum, http://www.adsl.com/adsl_vs_cable.html.

[83] It is estimated that cable modem users will have to share bandwidth with between 500 to 5,000 other data subscribers. Cable Datacom News, Overview of Cable Modem Technology and Services, http://cabledatacomnews.com/cmic1.htm. *See also* R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL (June 20, 1997).

[84] These analysts feel that most implementations of HFC take into account the effects of multiple users accessing the shared bandwidth and that the addition of more equipment at the head-end will solve any demand problems that would arise. *See* D. Shapiro, et al., Deutsche Morgan Grenfell Inc., Ind. Rpt. No. 1964154, Modems - Industry Report (Aug. 27, 1997) ("[A]n operator with a recently upgraded system would likely have plenty of capacity to devote two (yielding 60 Mb/s), three (yielding 90 Mb/s), or even four (yielding 120 Mb/s) 6MHz channels if demand proved to be sufficient. Moreover, the scalability of the architecture provides an even more robust solution. A node in a modern HFC plant contains not only two lit fibers (one downstream and one upstream), but also several dark fiber pairs. As a result, an operator could put another laser at the headend and another optical node unit (ONU) at the termination of one of the dark fiber pairs and effectively split the node in two: instead of 750 MHz serving one 1,000 home nodes, there would now be 750 MHz serving each of two 500 home nodes, thereby offering twice the capacity per home . . . With two more dark pairs left, it could be done yet again and again, if necessary, to create four 250 home nodes with 750 MHz of capacity each."). Cable modem defenders also contend that the "bursty" usage patterns of the Internet (and, presumably, other broadband applications) will result in very few instances of all users needing the entire bandwidth at the same time. *See ibid.* ("[T]he likelihood of all modem subscribers logging on simultaneously is slight, and owing to the bursty nature of data traffic, the probability that all on-line users will demand data at the same time is far slighter.").

[85] More than 4.5 million homes have been upgraded to receive cable modem service. Jeff Peline, Cable Modems Fight for Lead, *Cnet news.com*, http://www.news.com/SpecialFeatures/0%2C5%2C16615%2c00.html.

offering high-speed Internet access charge residential subscribers between $30 to $50 a month for service, including ISP service.[86]

Initial reports suggest that consumer acceptance of cable modem technologies is meeting or exceeding expectations. One recent report places the total number of cable modem subscribers at 450,000 as of mid-1998, with providers reporting growth rates in excess of 100 percent annually.[87] Roadrunner and Media One Express recently announced much higher than expected consumer acceptance in their Portland, Maine rollout, claiming that subscribership in that market had reached seven percent of all eligible customers and that the number of subscribers rivaled that of America On-Line.[88] One study projects that cable modem services will have 1.6 million users by the year 2000.[89] Other studies project over three million cable modem users by 2002.[90]

B. Upgrading telephony networks via digital subscriber loop ("xDSL") technologies

The local telephone network currently provides ubiquitous voice service and mass-market access to the Internet. Although the telephone network was not designed to carry digital data, it is rapidly being upgraded to do so more quickly and efficiently.

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[86] Ira Brodsky, *Cable Modems to the Rescue?*, Telephony, June 23, 1997. Bresnan Testing Cable Modems in Marquette, Michigan, Broadband Bob Report, Apr. 7, 1997, http://www.catv.org. Most customers are also charged a one-time installation fee that ranges from $99 to $175. Sun Country Cable Chooses Internet Ventures' PeRKinet Service, Broadband Bob Report, June 19, 1997, http://www.catv.org; Comcast Launches @Home Service in Middlesex County, N.J., Broadband Bob Report, May 6, 1997, http://www.catv.org.

[87] David Bowermaster, "Cable Modems Outpace ADSL," ZDNet (July 31, 1998), at www.dxnet.com/zdnn_display/ 0,3440,2125359,00.html.

[88] Press Release: Road Runner/Mediaone® Express Reach Customer Milestone, April 15, 1998, at http://www.pathfinder.com/rdrun/. The press released claimed 75,000 subscribers for these two services. Contrast this with a November 1997 report that only 60,000 subscribers had signed up on all cable modem services combined. P. Farhi, Slow Start for a Fast Connection, *Washington Post*, Tuesday December 23, 1997.

[89] Bill Pietrucha, Cable Modem Buildout Slower Than Expected, Newsbytes, Mar. 28, 1997. The Data Analysis Group predicts that 8 million cable modems will be sold in the US in 2001. Forecast Market for Cable Modems in Users Homes, US, Computer Industry Forecasts, Jan. 15, 1997, *citing* Cable Modems Bump into Network Roadblocks, Lightwave, Sept. 1, 1996 at 7.

Telephone companies are converting the existing analog copper loop to support high-speed digital transmissions. For data, the local loop is more than just the twisted-pair copper wire that runs between a subscriber's premises and the telephone company's central office; it also includes two modems at each end of the wire, one of which is controlled by the subscriber. Today, almost all Internet users use analog voice grade modems to connect their computers to the telephone network.[91]

The maximum speed of analog modems is lower than the maximum capacity that the copper wire will allow. Analog signals – whether from a telephone or a modem – are limited to using only certain frequencies within the copper wire. These usable frequencies represent 4 kHz of bandwidth, which in digital terms is equivalent to 64 kb/s. Most analog modems today operate at 28.8 or 33.6 kb/s.[92] The newest generation of analog modems is capable of 56 kb/s, the practical limit for analog modems.[93] But the copper wire used in local telephone networks has a theoretical bandwidth of 1

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[90] Cable Datacom News, Cable Modem Market Stats and Projections, http://cabledatacomnews. com/cmic16.htm.

[91] Analog modems convert the digital information generated by computers into a format that is identical to the analog voice signals produced by a telephone. At the central office, analog signals are received by another modem that digitizes the signal in order to send it through a digital switch. Approximately one-quarter of U.S. households have a personal computer (PC) equipped with an analog modem. According to Jupiter Communications, at the end of 1996 nearly 40 million households in the U.S. have PCs, for a penetration rate of 39 percent. Over 70 percent – 27 million – of these households have modems connected to their PCs, and over half of them – 15 million – use the Internet or other online services. Jupiter Communications Press Release, New Devices and Technologies Will Drive Net Into 36 Million Homes by 2000, Jan. 6, 1997.

[92] Note that 54 percent of households connecting to the Internet use 28.8 or 33.6 kb/s modems, 23 percent 56 kb/s, and 15 percent 14.4 kb/s or slower. The remainder of households (8 percent total) divide between ISDN, cable modems, ADSL, and satellite or wireless. Jupiter Communications Press Release, 56 Kb/s "Midband" Solution Will Dominate Home Internet Access, Oct. 17, 1996.

[93] We note that 56 kb/s is the practical limit for 56k modems. One observer estimates that between 25 and 40 percent of telephone lines will not support any connection speed faster than 33.6 kb/s, no matter what modem is connected to the line. Les Freed, Fast Connections for All?, PC Magazine, Oct. 21, 1996, at 83 (noting that lines connected to older "subscriber line concentrators" cannot transmit faster than 33.6 kb/s). Further, even with properly conditioned lines, 56k modems achieve speeds near 56 kb/s "only under laboratory conditions. Real-world speeds will average between 40 and 50 kb/s." *Id.* Standards disputes have also slowed the deployment of 56k modems. U.S Robotics (recently merged with 3Com) builds such modems to its own "x2" standard, while Rockwell and Lucent build to the incompatible AK56flex@ standard. The International Telecommunications Union is expected to ratify a standard for 56 kb/s modems this year, but there is no guarantee that current modems will be compatible with the standard. *Id.*

MHz.[94] The local loop can be upgraded to support much of the near-term demand for bandwidth without having to replace the embedded base of copper wire. The key to this upgrade is replacing the analog modems on the ends of the loop with digital ones.

The major telephone companies are now upgrading their networks with digital subscriber line (xDSL) technology.[95] Like ISDN, xDSL expands the capacity of the existing copper loop by replacing analog modems with digital adapters that use much more of copper's potential bandwidth and by dividing each existing copper wire into multiple channels. Unlike ISDN, however, xDSL enables the channels carrying data traffic to be diverted around the central office switch and onto packet-based networks. This frees up the circuit switches for voice traffic, and means that telephone companies can handle the increased demand for traffic by purchasing relatively inexpensive and efficient packet-routing equipment, instead of much more expensive circuit switched central office equipment.[96]

There are many varieties of xDSL technology, each of which provides different transmission rates to end users. Asymmetric DSL (ADSL) is at the low end of the range in terms of speed, but is also technologically closest to wide-scale deployment. As its name implies, ADSL provides asymmetric capacity, with very high bandwidth downstream and lower bandwidth upstream. The

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[94] Unshielded twisted pair copper wire has a current maximum bandwidth of 100 MHz, depending on wire gauge, insulation, and length of the wire. In the 1990s the Electronics Industry Association and Telecommunications Industry Association (EIA/TIA) developed a set of standards to define the maximum bandwidth of certain types of copper wire. *See* American National Standards Institute/Telecommunications Industry Association/Electronics Industry Association, Standard 568 A 95, Commercial Building Telecommunications Cabling Standard (Oct. 1995). The highest bandwidth is provided Category 5, capable of transmitting 100 MHz over 100 meters. Category 5 is the current standard for running high-speed local area networks within offices. Copper telephone outside plant is equivalent to Category 2, supporting 1 MHz of bandwidth.

[95] The industry refers to the alphabet-soup of DSL technologies, described below, by the generic acronym xDSL.

[96] *See* J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global *19 (Mar. 13, 1997) ("[S]ervice providers would need to add data communications equipment, such as Ethernet hubs and routers, rather than the far more expensive central office switching equipment.").

high-speed ADSL channel ranges from 1.5 to 8.44 Mb/s, and the upstream channel ranges from 16 to 640 kb/s. Other xDSL technologies under development promise bandwidths up to 52 Mb/s.[97]

Telephone companies have recently begun deploying ADSL,[98] although most other DSL technologies are still in the trial stage. Other xDSL technologies are expected to attract considerably fewer subscribers.[99] There have however, been recent problems with choosing a universal standard for ADSL, a factor which may slow its deployment.[100] A bigger concern with xDSL is that it has severe distance limitations: it cannot be used on very long loops (18,000 feet or more), which represent approximately 20 percent of all loops.[101] Moreover, the available bandwidth from xDSL

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[97] High data rate Digital Subscriber Line (HDSL) uses two lines and achieves rates of 1.544 Mb/s, equivalent to a T1 trunk. Single line DSL (SDSL) is similar to HDSL but uses only one line. SDSL can achieve the same throughput as HDSL with half the lines, but at shorter distances – 10,000 feet compared to 12,000 feet for HDSL. Very high data rate Digital Subscriber Line (VDSL) is used for the very shortest distances, and can achieve speeds of 13 Mb/s under 4,000 feet and up to 52 Mb/s at 1,000 feet. *See generally* ADSL Forum, General Introduction to Copper Access Technologies, www.adsl.com/ general_tutorial.html; ADSL Forum, ADSL Tutorial, www.adsl.com/adsl_tutorial.html.

[98] All the major U.S. local telephone companies are well into ADSL technical and market trials, and most expect widespread deployment of ADSL in their regions during 1998. GTE, Pacific Bell and U S West recently launched commercial ADSL service in certain cities in their regions, and Bell Atlantic and Bell South are in the process of doing so. *See* ADSL Forum, ADSL Trials and Service Deployments, http://www.adsl.com/trial_matrix.html. Some analysts fear that telcos might resist rapid ADSL deployment because they view it as a threat to their profit-producing installed base of T1 and other leased lines to business customers. *See* D. Shapiro, et al., Deutsche Morgan Grenfell Inc., Ind. Rpt. No. 1964154, Modems - Industry Report (Aug. 27, 1997) ("RBOCs are afraid of cannibalizing their lucrative T1 business by undercutting it with cheaper ADSL pricing"); Everen Securities, Inc., Ind. Rpt. No. 1926482, Convergence of LAN, WAN, & Internet (July 23, 1997) ("[B]efore xDSL will be widely deployed,] telcos must overcome the fear that those technologies will erode their bread-and-butter leased-line access business.").

[99] *See* T. Rudisill, et al., Raymond James & Associates, Ind. Rpt. No. 1816648, Local Access Market (Nov. 21, 1996) ("HDSL will continue to be driven by strong demand for 1.5 Mb/s digital service from the Internet Service Providers (ISPs), the transition from old repeatered T-1 lines to HDSL standards in the commercial market, and a move for fractional T-1 and full-duplex HDSL into the residential community."); Merrill Lynch Capital Markets, Ind. Rpt. No. 1910047, ADC Telecommunications (June 17, 1997) ("The HDSL market has begun to take off. Industry sources indicate about 488,000 lines will be deployed in 1997. That's almost 100% growth over 1996. Looking forward, very healthy growth rates are expected to continue.").

[100] AT&T/Lucent developed one standard, Carrierless Amplitude/Phase Modulation (CAP). As of December 1996, 90 percent of all deployed ADSL hardware was based on that standard, and "most trials have used CAP technology." Alan Stewart, The Battle for Bandwidth, *Communications News*, May 1997, at 36. But several standards bodies favor a different one, Discrete Multitone (DMT). ADSL, *Edge*, May 19, 1997; Anne Knowles, Incompatible ADSL Standards Duke It Out, *InfoWorld*, Dec. 23/30, 1996, at TW1. As independent observers note, "a standards war may prevent you from boarding this data communications bullet train." James Powell, Speedy ADSL Slow to Arrive, *Windows Magazine*, Aug. 1997, at 238.

[101] The addition of a digital remote terminal can help matters somewhat, by extending fiber closer to the home and

begins to fall-off considerably at distances greater than 9,000 feet from the central office.[102] Furthermore, even many short copper wires are deployed in ways that would require significant reconditioning before they could withstand the demands of ADSL.[103] ADSL modems are currently expensive – estimates range from $1,000 to over $3,000[104] – but these prices can be expected to drop fairly quickly once the technology matures.[105]

Recently, an industrial consortium of leading PC industry, networking and telecommunications companies joined together to create a subset of the existing ADSL standard to encourage the rapid deployment of ADSL technology. The new standard being developed, titled

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reducing copper loop lengths below 12,000 feet. *See generally* ADSL Forum, General Introduction to Copper Access Technologies, http://www.adsl.com/ general_tutorial.html; ADSL Forum, ADSL Tutorial, http://www.adsl.com/adsl_tutorial.html; Reohr Dot Com, Intelligence, ADSL: Turning Copper Into Gold, http://www.reohr.com/intelligence/papers/adsl2.htm.

[102] To achieve its maximum speeds, ADSL requires nearly the entire available bandwidth (about 1 MHz) of copper; transmission speeds slow quickly as line noise and signal loss (attenuation) rise. For long loops, telephone companies have installed loading coils that improve the signal quality within the 4 kHz used by analog devices, but reduce the available total bandwidth. Thus, while an 8.44 Mb/s downstream rate can ideally be achieved if the customers premises are less than 9,000 feet from the telco's switch, this rate goes down drastically if the distance increases. At a distance of 18,000, the downstream rate goes down to about 1.5 Mb/s. ADSL is not feasible if the distance is beyond 18,000 feet. Reohr Dot Com, Intelligence, ADSL: Turning Copper Into Gold, http://www.reohr.com/intelligence/papers/adsl2.htm.

[103] Even shorter loops can be bundled with many other loops when they leave the central office; splicing individual loops out of the bundle degrades their condition and increases line noise, reducing the maximum speed of ADSL. Reohr Dot Com, Intelligence, ADSL: Turning Copper Into Gold, http://www.reohr.com/intelligence/papers/adsl2.htm.

[104] *See* D. Shapiro, et al., Deutsche Morgan Grenfell Inc., Ind. Rpt. No. 1964154, Modems *6 (Aug. 27, 1997) ("Equipment costs remain high, at about $1,000 per modem pair:for ADSL, a modem is necessary both in the user's home and at the central office."); J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global *21 (Mar. 13, 1997) ("One of the key barriers to ramping up quickly is the cost per subscriber to install ADSL. Currently, costs are around $1,500-3,000 per subscriber."); R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL *30 (June 20, 1997) ("The single biggest delaying factor in the DSL network rollout is the current, but dropping, per-subscriber cost of the equipment. Current DSL modems carry an average price tag of $2,000-3,000, and the price is dropping.").

[105] *See* J.J. Bellace, et al., Merrill Lynch Capital Markets, Ind. Rpt. No. 1869480, The ABC's of Wireline Equipment: Global *21 (Mar. 13, 1997) ("Industry sources estimate these costs would have to drop to around $500 per subscriber or below for ADSL to become profitable for deployment. The cost is likely to come down once service providers begin buying large amounts of modems and equipment."); R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL *30 (June 20, 1997) ("While [$2,000-3,000 for an ADSL modem is] fine for tests, it is generally considered that the 'sweet spot' where DSL service becomes commercially viable on a wide scale is $500/unit. While IDC is projecting this price inflection point to be crossed in 1999, we think this is overly conservative."). Most analysts predict that agree that ADSL will not be commercially viable until the price drops to $500.

"Universal ADSL" or "UADSL" would permit a rapid deployment of ADSL supporting rates of up to 1.5 Mb/s in the downstream and 384 kb/s in the upstream. One of the claimed advantages of UADSL is that it does not require the installation of a "splitter" at the residence, and thus could offer network operators the ability to upgrade for high-speed data simply by installing a UADSL modem at the central office/point of presence. Computer manufactures would supply the residential UADSL equipment as a plug and play card in a PC, or as part of a modem shipped with the PC, so that consumers only need to connect their UADSL modem to an UADSL enabled line to obtain service. The Universal ADSL Working Group ("UAWG") recently announced the completion of an initial specification and its intention to continue to pursue adoption of a standard by the International Telecommunications Union ("ITU") by October 1998.[106]

It appears to be too early to predict the degree of consumer acceptance of ADSL offerings. In Phoenix, US West launched its DSL service in October 1997 and within a week 1,700 customers requested service, twice what the company expected.[107] Some analysts predict that ADSL will have as many as two million residential and small business users by the turn of the century.[108] On the other hand, ADSL currently lags far behind cable modems in terms of deployment, with approximately 25,000 users, compared with 450,000 cable modem subscribers.[109]

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[106] http://www.uawg.com, http://www.uawg.com/html/june_9_1998.html.

[107] T. Hanrahan, The Bandwidth Oasis, *Wall Street Journal Interactive Edition*, December 15, 1997, http://interactive.wsj.com/edition/resources/documents/net97Cover.htm.

[108] *See* R.M. Maclellan, et al., Dillon, Read & Co., Ind. Rpt. No. 1924563, Introduction to xDSL (June 20, 1997); *id.* at Tables 8 (showing residential ADSL deployment to be 1.52 million, or 3.5 percent of the residential PC/modem base, by 2000); *id.* at Table 9 (showing small-business ADSL deployment to be 290,000, or 5.3 percent of the small-business PC/modem base, by 2000).

[109] See Bowermaster, Cable Modems Outpace ADSL.

C. Other broadband technologies

1. Fixed wireless (MMDS, LMDS) technologies

Fixed wireless technologies are expected to play an increasingly important role in the local loop, particularly for data services.[110] WinStar, a rapidly growing provider of local services, recently launched its fixed-wireless service, Wireless Fiber, using the 38 GHz band of spectrum. The service provides local, long distance and Internet access services over a network of roof-mounted access antennas that terminate on a landline switch.[111] Other competitors, including AT&T, are expected to offer fixed wireless services in the near future.[112]

LMDS. Local Multipoint Distribution Service (LMDS) is a digital microwave broadband service that operates at very high frequencies with capacious bandwidth.[113] LMDS licensees may control up to 1.3 GHz of wireless spectrum, which can be used to carry data at speeds in excess of 1 Gbps.[114] LMDS can provide customers with multichannel video programming, telephony, video

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[110] Jill Abeshouse Stern, Towering Above Us, *New Jersey Law Journal*, Dec. 16, 1996, at 32.

[111] New Paradigm Resources Group and Connecticut Research, 1997 Annual Report on Local Telecommunications Competition 552 (8th ed.1996). WinStar bills Wireless Fiber as "the functional equivalent of fiber in terms of reliability, data transmission quality, and bandwidth provided to the end user." WinStar and U S West Sign Interconnect Agreement for Colorado, *Edge*, Apr. 7, 1997.

[112] NextWave Telecom and Sprint PCS may enter using their PCS spectrum in a manner similar to AT&T. Advanced Radio Telecom, which holds 38 GHz licenses in 47 markets nationwide is rolling out wireless local loop services. Teleport Communications Group recently purchased BizTel Communications, which has 38 GHz licenses in 48 states. In February 1997, AT&T introduced a new fixed wireless system that will provide households with the equivalent of an ISDN line, with two voice lines and 128 kb/s data speeds. The technology is intended to provide high-speed, high-quality, secured bandwidth to provide faster data services and full-motion video conferencing. AT&T is currently trialing the system in Chicago, and plans to deploy it commercially in 1998.

[113] LMDS systems consist of a multicell configuration distribution system with return path capability within the assigned spectrum. Generally, each cell will contain a centrally located transmitter (hub), multiple receivers or transceivers, and point-to-point links interconnecting the cell with a central processing center and/or other cells. FCC, Wireless Telecommunications Bureau, LMDS Fact Sheet, Sept. 5, 1997, http://www.fcc.gov/wtb/auctions/lmds/lmdsfact.html.

[114] VIPC, Inc., LMDS: Answers to Frequently Asked Questions, Oct. 18, 1997, http://www.ajs2.com/lmds/faq.htm. The FCC's decision to allow 1150 MHz of spectrum to be auctioned to a single operator in each BTA (with a much smaller 150 MHz available as well) allows for unparalleled services to be offered, now and well into the future. US Wavelink, What Is LMDS?, Sept. 18, 1997, http://www.uswavelink.com/ what_is_lmds.html.

communications, and two-way data services.[115] LMDS has true duplex capability, unlike most competing broadcast technologies. This allows for deployment of effective two-way voice and data services, and paves the way for future interactive video services to be added, with little or no additional infrastructure cost.[116] LMDS uses a small-cell configuration, and is able to polarize and reuse spectrum very effectively over a small area. CellularVision currently operates the only commercial LMDS site in the United States.[117] Although the deployment schedule for LMDS is highly uncertain, many major industry players – including AT&T, MCI, Sprint, GTE Corp. and Ameritech – have expressed interest in deploying the technology.[118]

LMDS requires a clear line of sight and is subject to fading due both to rain and foliage, thus has technical limitations which could be a substantial impediment to high penetration rate

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[115] Hewlett-Packard envisions enough bandwidth for "most homes in a neighborhood to watch separate digital movies, teleconference, and surf the Internet at high speed all at the same time." VIPC, Inc., LMDS: Answers to Frequently Asked Questions, Oct. 18, 1997, http://www.ajs2.com/lmds/faq.htm. LMDS is capable of providing a variety of one-way and two-way broadband services. Because of its numerous applications, LMDS has the potential to become a major competitor to local exchange and cable television services. FCC, Wireless Telecommunications Bureau, LMDS Fact Sheet, Sept. 5, 1997, http://www.fcc.gov/wtb/auctions/lmds/lmdsfact.html.

[116]A business case was compiled which evaluated an LMDS deployment in the Santa Clara Valley of California. The primary uses assumed in this study were work at home and high speed Internet access. The scenario assumes 7 business cells and 22 residential cells, each assumed to be 4km x 4km. There are an estimated 13,150 homes per cell. The cost to obtain LMDS spectrum is estimated to be $16 per household covered. Ten percent of covered homes are assumed to have signed up by the third year for service costing $150 per month (which is expected to be paid by employers), 60 percent of major employers are also assumed to have signed up by the third year for service costing $3000 per month. Customer premise equipment is estimated at $650 per home (includes a roof mounted transceiver, a downconverter, and an Ethernet adapter). The cost of the LMDS hub is expected to be $370,000 and interconnection charges are expected to cost $10,000 per hub. VIPC, Inc., LMDS: Answers to Frequently Asked Questions, Oct. 18, 1997, http://www.ajs2.com/lmds/faq.htm.

[117] CellularVision was awarded a pioneer's license in Brighton Beach area of New York for its role in developing LMDS. CellularVision provides over 40 analog channels of video programming to its 12,000 subscribers, and is currently expanding the number of operating cells in the New York area. VIPC, Inc., LMDS: Answers to Frequently Asked Questions, Oct. 18, 1997, http://www.ajs2.com/lmds/faq.htm. LMDS enables customers to bypass over-burdened phone lines to access the Internet at 500 kb/s, at four times the speed of an ISDN line (128 kb/s) and 20 times the speed of a 28.8 kb/s modem. Jason Daponte, CellularVision Offers Wireless High Service, Total Telecom, June 23, 1997, http://www.totaltele.com/cgi-bin/disp.cgi?id=3131&type=article&template=more.html. CellularVision of New York has begun marketing CVDN 500 in Manhattan and Brooklyn, where it offers a 49-channel subscription television service. *Ibid.*

[118] Total Telecom, U.S. Operators on Blocks for Wireless LMDS, Aug., 11, 1997, http://www.totaltele.com/cgi-bin/disp.cgi?id=5530&type=article&template=more.html

deployments. However, LMDS may be a crucial technology for broadband services provided to small businesses and high-end residential customers if competition in the wired arena is slow in coming.

MMDS. Another form of fixed wireless, Multipoint Multichannel Distribution Service (MMDS), also shows promise as a broadband distribution system. MMDS is now used for analog wireless cable-TV services, but is being upgraded to provide residential and business Internet access at speeds up to 27 Mb/s.[119] Operators have been experimenting with both one-way service (using spectrum for the downstream link, and telephone lines for the uplink) and two-way service (using spectrum in both directions).[120] A key limitation of MMDS, like LMDS, is that it requires a clear line of sight between the transmitter and receiving antenna, which makes the service unavailable in many geographic areas and in certain weather conditions.

2. Land based mobile wireless technologies

Mobile wireless data services have been built based on existing cellular telephone platforms, beginning with receive-only paging services, and now extending to two-way wide area packet based networks. Cellular digital packet data ("CDPD") technology has been developed to transmit data over the cellular network in the idle times between voice transmissions, and supports data rates of 19.2 kb/s. In the US the ARDIS cellular data network has been operating for more than 10 years and has over 40,000 subscribers which send and receive data at 19.2 kb/s. RAM mobile data

[119] Gerry Blackwell, Wireless Access Enters Real-World Trials, Internet World, May 1997, at 15.

[120] MMDS operates in the 2 GHz band of radio spectrum and has a range of 35 miles. Although operators are currently licensed only for one-way, the FCC recently granted a license to MMDS operator CAI Wireless systems to offer two-way services in Boston. Various operators have already begun limited deployment of MMDS for high speed Internet access service under this arrangement.

operates a wireless network that provides service to more than 92 percent of the US urban business population.[121]

The Ricochet wireless modem system and service offered by Metricom has proven to be a great success in the limited markets presently served which include Washington D.C., the San Francisco Bay Area, and Seattle, Washington, along with a number of major airports.[122] Ricochet subscribers are provided with data rates of 28.8 kb/s – 40 kb/s. The Ricochet system uses unlicensed spectrum in the 902-928 MHz spectrum and closely spaced transmitters to provide coverage.

Wireless Local Area Networks (LANs) which can support data rates of 1 Mb/s or above are typically deployed in situations where limited roaming (within a department, building or campus) is sufficient. These networks use unlicensed spectrum and are based on spread-spectrum technology.

Although it is unlikely that the use of mobile wireless technologies will support the deployment of advanced telecommunications capabilities to "all Americans," the ability to provide mobile connectivity to a significant number of business subscribers plays an important role in the deployment of advanced services. Advances in compression and network technologies will ultimately permit these systems to transport video at 384 kb/s or above.

3. Satellite technologies

Since 1994, DBS has been offering broadband video services nationwide at prices competitive with cable operators. More recently, DBS operators have introduced two-way services

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[121] Wireless Data Communications: An Overview, The Choices, The Considerations, Motorola Inc., Wireless Data Group, available at http://www.mot.com/MIMS/WDG/techLibraryDir/whitePapersDir/index.html.

[122] A new sense of what modems could be, *Online U.S. News*, (April 6, 1998) http://www.usnews.com/usnews/issue/980406/6metr.htm, and from http://www.ricochet.com

that use the telephone line as a return-path.[123] Hughes offers its DirecDuo service, which provides both high-speed (400 kb/s) Internet access and DBS video programming through the same satellite dish. There are currently 4.4 million DBS homes,[124] although it is uncertain how many of these also subscribe to DBS data services.

Although the two-way capabilities of DBS are limited, there are currently numerous efforts underway to deploy broadband satellite networks with much larger upstream bandwidth. The largest of these projects are Teledesic[125] and Celestri,[126] which will rely on low-earth orbit (LEO) satellites to build international satellite backbone networks.[127] In addition, there are at least five proposals to deploy narrow-to-mid-band satellite networks that would provide personal communications services to end-users, as opposed to backbone services to businesses and ISPs.

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[123] DBS providers began delivering on-line services and the Internet to their customers beginning in 1996. Steve Higgins, Direct Broadcast TV May Go Further Than Many Predicted, *Investor's Business Daily*, Nov. 16, 1995, at A8.

[124] Subscribership is growing 100 percent annually. D.H. Leibowitz, et al, Donaldson, Lufkin & Jenrette Securities, Ind. Rpt. 2541409, Media and Entertainment (Mar. 24, 1997).

[125] Teledesic promises to build the "Internet in the sky". Teledesic's current plan is to deploy 288 LEO satellites, which is significantly less ambitious than it original plan to deploy 840. The company plans to launch its first satellite sometime in 2001. When it actually begins service (expected in 2002), Teledesic states that "from day one" it will be able to offer "fiber-like . . . broadband telecommunications access for businesses, schools and individuals everywhere on the planet." Teledesic's network will operate in the Ka-band (28.6 - 29.1 GHz uplink and 18.8 - 19.3 GHz downlink), and will offer most users a 64 Mb/s downstream connection and a 2 Mb/s upstream connection. Users with "broadband terminals" will enjoy a two-way 64 Mb/s connection. The terminals can interface with IP, ISDN, ATM, and other network protocols.

[126] In June 1997, Motorola announced the formation of Celestri, a $13 billion broadband LEO satellite network that is expected to begin providing service in 2002. Unlike Motorola's other LEO network, Iridium, Celestri is intended to serve as a broadband Internet backbone.

[127] Behind Teledesic and Celestri, the most ambitious broadband LEO project is Skybridge, which is being backed by Alcatel and Loral. The $3.5 billion Skybridge proposal calls for 64 LEOs to be launched in time for operations to begin in 2001. Skybridge would provide upstream connections of between 16 kb/s and 2 Mb/s, and downstream connections of 16 kb/s to 60 Mb/s. The remaining broadband satellite proposals call for geostationary satellites instead of LEOs. Loral is backing a $1 billion project called Cyberstar. It relies on a yet to-be-determined number of geostationary satellites. It would provide data and video services at between 400 kb/s and 30 Mb/s. Lockheed is backing Astrolink, which relies on 9 geostationary satellites to provide up to 9.6 Mb/s connections. The $4 billion Astrolink project is scheduled to begin operations in late 2000. Finally, GM-Hughes is backing the $3.5 billion Spaceway project, which would (initially) use 8 geostationary satellites to provide 6 Mb/s connections.

The largest and most advanced of the narrow-to-mid-band LEO projects is Iridium.[128] Iridium, which initially planned to offer services by the end of 1998, but has recently experienced delays and will distribute two thousand handsets to individual, corporate and government customers in late 1998 to test services.[129]

V. REMOVING BARRIERS TO COMPETITION AND DEPLOYING ADVANCED TELECOMMUNICATIONS CAPABILITIES ON A "REASONABLE AND TIMELY BASIS".

In this NOI the Commission raises the issue of how to remove barriers to competition for the deployment of advanced telecommunications capabilities. A related question is that of how market forces will propel the development of broadband facilities, and how this can happen in a regulated vs. unregulated environment. The least regulated segments of the telecommunications industry – long-distance, wireless and information services – already have attracted large investments in broadband facilities. An enormous amount of additional investment is still needed, however, to supply broadband local transport to all Americans. But the carriers that supply most local transport

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[128] Iridium was conceptualized in 1987 by Motorola engineers as a LEO-based, wireless personal communications network "designed to permit any type of transmission – voice, data, fax, or paging – to reach its destination anywhere on earth." Iridium, The Iridium System, http://www.iridium.com/ systm/systm.html. In 1992, the FCC granted Iridium an experimental license; an operational license was granted in 1994. Motorola is Iridium's primary investor and contractor. Other major investors include Lockheed Martin, Raytheon, and Sprint. Iridium plans to launch 66 satellites total. Half of Iridium's constellation was in orbit by the end of September 1997. Service is expected to commence in 1998. The Iridium system interacts with end-users over the L-band, and the satellites, gateways, and earth stations interact over the Ka-band.

[129] D.H. Leibowitz, et al., Donaldson, Lufkin & Jenrette, Ind. Rpt No. 2502083, Wireless Communications Industry: Global, at 53 (June 5, 1996); Denise Pappalardo, Satellites Ready for Data Service Launch, Network World, Mar. 24, 1997 at 12. American Mobile Satellite has also launched a satellite service in the United States to offer fixed telephony and data services to areas unserved by the public network. A report by the Federal Aviation Administration predicts that up to four big LEOs and three little LEOs will be deployed between 1996 and 2005. GlobalStar has publicly projected subscriber counts of 30 million mobile voice and data users by 2010, See also the recent news on Iridium, Iridium delays launch of global system, in *Yahoo!Finance*, http://biz.yahoo.com/rf/980909.bot.html.

today – local exchange carriers and cable operators – are the most heavily regulated entities in the telecommunications industry. The economic incentives of these carriers are in large part still determined by regulatory policy, not market forces. Numerous regulatory impediments greatly reduce the incentives that incumbent local exchange carriers and cable operators have to deploy broadband facilities. In many cases, these same regulatory restrictions also deter would-be competitors from deploying local broadband access facilities.

A. The history of cable regulation gives a clear indication as to the effect of regulation on growth

The history of cable television regulation, since its invention in 1948 and development as a widespread commercial product in the 1970s, is a tale of massive inconsistency. Regulators have had a difficult time categorizing cable television, which has characteristics of both common carriage (i.e. telephony) and broadcasting (i.e. television).[130] The history of cable regulation has led some to conclude that "from the 1960s to the 1990s the authorities took the worst of both regulatory models and piled them high on top of cable, to the point where they almost killed it."[131]

Cable prices, which previously were regulated by local franchising authorities, were deregulated by act of Congress in 1984. The 1984 Act established that cable rates would be deregulated wherever there was "effective competition" for the provision of television. The Commission determined that the effective competition test would be met by the presence of three broadcast television signals – a test which was easily met and which resulted in the de facto deregulation of cable television prices virtually everywhere.[132]

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[130] *See* Peter Huber, *Law and Disorder in Cyberspace* (New York: Oxford University Press, 1997), especially Chapter 5.

[131] *Ibid*, pp. 61-2.

[132] For an excellent discussion, see Thomas J. Duesterberg and Peter K. Pitsch, *The Role of Competition and*

By 1992, however, rising cable TV prices led members of Congress to re-impose price controls. The Cable Act of 1992 required that the FCC ensure that cable rates were "reasonable," and the Commission reacted by imposing first a price freeze, then a 10 percent across the board rollback, and then a further seven percent across the board rollback. Not surprisingly, these government-imposed price cuts substantially reduced the market valuation of cable television companies, hindering their ability to raise capital for network upgrades and other needed modernization. The price controls did not, however, benefit consumers, who suffered from reduced service offerings, lower quality of service and an overall price-quality combination they found less attractive than before re-regulation.[133]

By 1996, Congress appeared to have recognized its mistake. Motivated by complaints from a number of sources, and by the presence of increasing competition to cable from the satellite broadcasting industry, it used the Act as a vehicle to effectively end price regulation of cable television effective March 31, 1999.

Deregulation of prices, per se, does not by any means end Federal or local regulation of the cable television business. Cable remains subject to local franchising fees (up to five percent of revenues), "must-carry" rules (which force cable operators to carry programming for which they receive no compensation), restrictions on cross-ownership of stations and on ownership of programming – plus an array of local franchising requirements.

Perhaps of even greater concern, recent statements from leading members of Congress have suggested that cable deregulation is not yet a "done deal" – that rate "re-regulation" may once again

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Regulation in Today's Cable TV Market (Washington, DC: The Hudson Institute, 1998), pp. 5-10.

133 *See* Duesterberg and Pitsch, pp. 6-7, supra.

lie in cable's future. Such an action, which undoubtedly would be aimed at once again freezing or rolling back cable television prices, could deliver a body blow to the ability of cable television operators to undertake the kinds of investments in broadband services required to extend advanced telecommunications capabilities to all Americans..

Further, the status of cable under the Act is anything but secure. As cable companies increasingly compete in the markets for local telephone service and Internet access, there is a very real possibility that the Commission will feel obliged to bring cable – including the data services it increasingly provides – under a new, more intrusive regulatory regime. The establishment of separate subsidiary requirements for incumbent LECs who wish to provide advanced services on an unregulated basis will no doubt led to petitions intended to bring cable data services into that regulatory regime.[134]

B. Deployment of broadband capable networks requires substantial investment which will only occur in a deregulated environment

Cable companies and incumbent LECs are subject to a wide-ranging and highly intrusive regulatory apparatus that affects virtually every aspect of their operations. The regulations that have the greatest effect on their ability and incentives to deploy broadband capacity fall into two main categories; rate and entry regulation, and resale and unbundling requirements. In addition, both sets of firms are subject to a variety of other impediments, such as "must carry" rules for cable, and the Inter-LATA restriction for telephone companies.

Rate and Entry Regulation: Incumbent local exchange carriers and cable operators are subject to a variety of restrictions regarding the types of services they may offer over their networks

[134] *See* Barbara Esbin, *Internet Over Cable: Defining the Future in Terms of the Past*, OPP Working Paper No. 30 (August 1998).

and the rates, terms and conditions at which these services must be provided. Section 214 of the 1934 Communications Act prevents phone companies from constructing new facilities or discontinuing existing service without advance permission.[135] Section 201 of the Act enables the Commission to regulate what sort of devices can be connected to the telephone network, and thereby what kind of add-on services can be offered over telephone lines.[136] Local telephone companies must file tariffs and cost support information for each of their common carrier offerings with either state or federal regulators, or both. Any new service that a local telephone company seeks to offer must be added to its tariff.

Title VI of the Communications Act extends franchise[137] and rate regulations[138] to the provision of "cable services."[139] As discussed above, cable MSOs remain subject to rate regulation for their "basic" services through March 31, 1999. The current regulations resulted in dramatic reductions in the ability of cable companies to attract capital, without any commensurate benefits for consumers. Indeed, most observers credit the failure of the proposed Bell Atlantic/TCI merger in 1994 to the imposition of the second round of mandated price rollbacks by the FCC in February of that year.[140] Delay or cancellation of the rate deregulation scheduled for next year may result in another round of canceled mergers and delayed entry by cable operators into the broadband marketplace, insuring further delay in the deployment of advanced services by cable operators.

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[135] 47 U.S.C. '214(a).

[136] 47 U.S.C. '201.

[137] 47 U.S.C. '541.

[138] 47 U.S.C. '543.

[139] 47 U.S.C. '22(6).

[140] *See* Duesterberg and Pitsch. *See also* Peter K. Pitsch and David Murray, "Are Telecom Mergers Anticompetitive: Lessons of the Cable-Telco Mergers of 1993," Future Insight 3.1 (Washington, DC: The Progress & Freedom Foundation, June 1996).

Existing rate and entry regulations reflect the conclusion that regulators can allocate goods and resources and set prices more efficiently than market forces. In some instances (declining in number as new technology and the globalization of most markets spur competition) this may be true. Unregulated natural monopolies, for example, may price too high, and produce too little. But the beneficial effects of regulation (such as they are) can only be realized if regulators perform their functions efficiently, on schedule, on the basis of up-to-date information, and to protect the public, not industry incumbents. The Commission must by definition take a long and careful look at each problem that it confronts: few would argue that a fast but capricious government agency would serve the public well. However, the result is that regulatory decisions have an extremely long time factor built in: as an example, routine licensing decisions take far longer than they should. The resulting delay often solidifies the economic status quo, protects incumbents against would-be competitors, and deprives the public of new services at lower prices.[141]

Meanwhile, ratemaking proceedings provide a ready forum for critics that continuously try to tug incumbents in two diametrically opposed directions. One group of critics claims that broadband investment is not responsive to consumer demand, and thus a form of wasteful goldplating that harms ratepayers. Another group claims that broadband investment is behind consumer demand, and blames incumbents for being insufficiently responsive to subscribers' needs.

[141] Indeed, the NPRM associated with this NOI is a perfect example. Reacting to petitions filed in early 1998, the Commission issued its NPRM in August, hoping (in a best case world) to issue a final rule in February 1999. Even if the Commission is able to meet this goal, litigation will almost surely preclude a "final" outcome at the Federal level before mid-1999. At that point, as the Commission has emphasized, further action by state PUCs would be required to implement the separate subsidiary approach promised in the NPRM. In many cases, states thus far have been reluctant to approve the actions that would be required under the NPRM's approach, and even those that do so may impose further requirements. In short, the NPRM – no matter how deregulatory its intent – sets in motion a chain of regulatory and legal processes that seems unlikely to produce a stable regulatory framework for digital broadband services offered by Incumbent LECs before the end of the millenium – if ever.

In truth, there is only one way to determine the market's true need for broadband investment: let market forces, not regulators or special interest groups, drive investment decisions.

Carriers' decisions to offer new services are also affected by the inherent uncertainty involved in whether authorizations and tariff approvals are needed in the first instance. A carrier seeking to provide a new broadband service must determine what kinds of regulation apply to its proposed service. Will the new service be regulated or unregulated? Basic or enhanced? Intrastate or interstate? Local or long-distance? IntraLATA or interLATA? Is a separate affiliate required? In many instances, however, a carrier will not know how a proposed service will be regulated and whether the carrier can offer it all. Many broadband services simply do not conform to established regulatory categories. On the Internet, for example, it is almost impossible to track where calls originate, what communications paths are traveled, or where information is ultimately delivered or consumed. Yet every telephone service must be categorized as intra- or interstate and intra- or interLATA. The Commission has declined to adopt objective criteria to determine whether Internet services related services are interLATA in nature, but has instead stated that it will make this determination on a case-by-case basis.[142]

The need to squeeze new services into regulatory categories to which they simply do not fit has a dilatory effect on the ability of carriers to quickly introduce products to market. Regulatory uncertainty is further compounded by the lack of uniformity among the states – each of which has its own unique regulatory requirements – and between the states and federal regulators. Moreover,

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[142] *See* First Report and Order and Further Notice of Proposed Rulemaking at 127, *Implementation of the Non-Accounting Safeguards of Sections 271 and 272 of the Communications Act of 1934*, CC Dkt. No. 96-149 (rel. Dec. 24, 1996). The Commission did emphasize, however, that "[i]f a BOC's provision of an Internet or Internet access service (or for that matter, any information service) incorporates a bundled, in-region, interLATA transmission component provided by the BOC over its own facilities or through resale, that service may only be provided through a section 272 affiliate, after the BOC has received in-region interLATA authority under section 271." *Id.*

with technologies quickly evolving, carriers face the constant risk that regulatory commissions will alter their treatment of new services after they have already been introduced. For example, ISDN is sold by local exchange carriers as a single, high bandwidth line. Each individual ISDN line contains three separate channels that can be used to send and receive information in any configuration that the subscriber wishes. In 1995, the Commission held that only one subscriber line charge (SLC) should be applied to each ISDN line.[143] In its 1997 *Access Charge Reform Order*, the Commission changed course again: it ordered one, newly-calculated, ISDN-only SLC to be charged per ISDN line, but changed the amount of the SLC.[144] There is no guarantee that these issues will not be revisited, and further reversals are possible. State regulation complicates things further. Delaware regulators, for example, invalidated Bell Atlantic's ISDN tariff because they thought that Bell Atlantic had not adequately explained why ISDN should cost more than regular analog service.[145] A Delaware court overturned the ruling – more than nine months later.[146] Regulatory uncertainty of this kind clearly acts as a strong disincentive to investment in ISDN facilities in the first place.

Numerous disincentives to invest have been created through specific pricing mechanisms. One example is the level at which the Commission has set the "productivity offset" or "X-factor."

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[143] Action, Common Carrier Bureau Will Not Enforce Current Rules on Application of Subscriber Line Charges to ISDN Service, 10 FCC Rcd 13473 (1995), *reversing*, In the Matter of NYNEX Telephone Companies, Revisions to Tariff F.C.C. No. 1, Transmittal No. 116, Memorandum Opinion and Order, 7 FCC Rcd 7938 (1992), *affd. on recon.*, 10 FCC Rcd 2247 (1995).

[144] First Report & Order at & 116, *Access Charge Reform*, FCC 97-158, CC Dkt. No. 96-262 (F.C.C. rel. May 16, 1997).

[145] *In the Matter of the Application of Bell Atlantic-Delaware, Inc., to Replace the Existing Tariff for Residential BRI Service*, Dkt. No. 96-009T, Order No. 4246, 1996 Del. PSC Lexis 224, & 14 (Del. PSC Jul. 2, 1994) (noting with approval that hearing examiner had ordered a charge that was identical to that of the unlimited local usage package offered subscribers of residential dial tone.

[146] *Bell Atlantic - Delaware, Inc. v. PSC*, C.A. No. 96A-07-003, 1997 Del.Super. Lexis 113 (Super. Ct. for Kent County, Apr. 4, 1997).